

中国龙脑香科植物纪要\*

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摘要: 广义的龙脑香科是泛热带分布。中国有 5 属 12 种, 其中 1 种为引种栽培, 产云南、广西、海南及西藏。本科分布北界在印度的喜马偕尔邦, 在该地粗壮娑罗双 *Shorea robusta* 约达北纬 31°。《中国植物志》所报道见于我国的纤细龙脑香 *Dipterocarpus gracilis* 确实未见于我国。我国自然生长的东京龙脑香 *Dipterocarpus retusus* 依据毛被的多少可分为 2 个变种, 它们可能同时出现在同一林中。由于毛被多少不是区分种的可靠特征, 因此将河内坡垒 *Hopea hongayanensis* 及多毛坡垒 *H. mollissima* 两者都归并到狭叶坡垒 *H. chinensis*。鉴于雄蕊数目的不确定性, 海南所产的 *Hopea exalata* 与越南所产的 *H. reticulata* 就视为同一种, 而采用后者作为种名。版纳青梅 *Vatica xishuangbannaensis* 与广西青梅 *V. guangxiensis* 两者以叶脉数目来区分是不可靠的, 也应视为同种而采用后者作为种名。经野外实地考察, 望天树 *Parashorea chinensis* 仍应恢复其原来的学名。

关键词: 龙脑香科; 分类; 中国

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Notes on Dipterocarpaceae of China\*

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**Abstract:** Dipterocarpaceae s.l. is a pantropical family. Twelve species in China, one of which is introduced, in five genera are distributed in Yunnan, Guangxi, Hainan and Xizang. The northern boundary of the family lies in Himachal State in India where *Shorea robusta* reaches nearly 31 degrees north. *Dipterocarpus gracilis*, which is reported in FRPS, is certainly not found in China. Two varieties of *D. retusus* are recognised in China, which may co-occur in the same stand. Both *Hopea hongayanensis* and *H. mollissima* were reduced into *H. chinensis* because tomentum is not a reliable character to differentiate dipterocarp species. *Hopea exalata* is considered as a synonym of *H. reticulata* based on the instability of

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stamen number. *Vatica xishuangbannaensis* cannot be distinguished from *V. guangxiensis* as the variation of the number of leaf lateral veins. *Parashorea chinensis* is confirmed to be placed in this genus by living materials in Chinese tropical area.

**Key words** : Dipterocarpaceae ; Taxonomy ; Chinese

## Introduction

The family Dipterocarpaceae , consisted of three subfamilies , 17 genera and approximately 529 species , is disjunctively distributed in the tropics of Asia , Africa and South America ( Ashton , 1982 ; Londono *et al* , 1995 ). The Asian subfamily Dipterocarpoideae is included about 470 species of 13 genera and concentrated in the Malesian area especially in northwest Borneo ; the South American subfamily Pakaraimoideae contains one monotypic genus ; the subfamily Monotoideae consists of a monotypic South American genus and two African genera included 39 species ( Ashton , 1982 ; Londono *et al* . , 1995 ). Ashton ( 1982 ) considered that the geographical change in the Tertiary resulted in the disjunctive pattern of distribution of the three subfamilies. After restoration of Monotaceae and transference of genus *Pakaraimaea* into Tiliaceae ( Takhtajan , 1997 ) , Dipterocarpaceae s.s. is widely regarded as a characteristic family of Old World Tropics or Asian Tropics. Its distributional range especially its northern boundary is the basis of division of Asian tropical vegetation and floristic area. But Dayanadan *et al* . ( 1999 ) more recently showed by molecular phylogenetic analysis that *Pakaraimaea* and *Monotes* are more close to Dipterocarpoideae than to any other family , and do merit including together in Dipterocarpaceae.

Although the Chinese species of Dipterocarpaceae have been reported in the “ Flora Reipublicae Popularis Sinicae ” ( FRPS ) ( Tao & Tong , 1990 ) and “ Higher Plants of China ” ( Lin , 2000 ) , the taxonomic treatments especially for the region of SE Xizang were incomplete because of the insufficient knowledge about the generic and specific delimitations as well as their distribution. Since the publication of *Parashorea chinensis* ( Wang , 1977 ) , its systematic position has been the subject of persistent debate ; it has been ascribed to genus *Shorea* by Zhu & Wang ( 1992 ). Yang ( personal communication ) even considered that genus *Parashorea* should be reduced into genus *Shorea* . Recently , Li & Xu ( 2001a , 2001b ) discussed the taxonomic treatments for *Parashorea chinensis* and *Vatica guangxiensis* on the basis of population genetic structure and differentiation , Kajita *et al* . ( 1998 ) and Tsumura *et al* . ( 1996 ) discussed the generic relationships in the family based on molecular sequences data.

In spite of the limited species occurred in China , it is very necessary for us to take account of this group of plants owing to its importance for understanding Asian tropical vegetation and floristics , as well as its confusion of species for hindering further research. During the work for “ Flora of China ” ( FOC ) , we have examined the Chinese herbarium specimens and investigated the living materials in Chinese tropical area , now we try to answer the question : how many genera and species are occurred in China ?

## Taxonomic treatments for Chinese Dipterocarpaceae

### Dipterocarpaceae

Trees, evergreen or semi-evergreen, rarely deciduous in dry season. Xylem with aromatic resin in intercellular resin canals. Branchlets with stipular scars, sometimes annular. Leaves simple, alternate; stipules large or small, persistent or caducous; leaf margin entire or sinuate-crenate; lateral veins pinnate. Inflorescences few- or many-flowered terminal or axillary racemes or panicles; flowers usually sweet-scented, bracts usually minute, rarely large and persistent, usually fugacious. Inflorescences, calyces, petals, ovary, and other parts usually with stellate, squamate, fascicled or free-standing hairs. Flowers bisexual, actinomorphic. Calyx lobes 5, free or united at base, imbricate in bud if not united. Petals 5, adnate or connate at base. Stamens (10-) 15-many, free from or connate to petals; filaments usually dilated at base; anthers 2-celled; connective appendage aristate, filiform or stout. Ovary superior, rarely semi-inferior, slightly immersed in torus, usually 3-celled, each cell 2-, rarely many-ovuled; ovules pendulous, lateral or anatropous. Fruit usually nut-like, sometimes capsular and 3-valved, 1-, rarely 2-many seeded, with persistent variously accrescent calyx of which 2 or more lobes are usually developed into lorate wings. Seed exalbuminous; cotyledons fleshy, equal or unequal, applanate or  $\pm$  folded or cerebriform, entire or lacinate; radicle directed towards hilum, usually included between cotyledons.

About 17 genera, 529 species, distributed in tropical Asia, Africa and America. In Asia, most species and genera exist in northwest Borneo. Twelve species in China, one of which is introduced, in five genera distributed in Yunnan, Guangxi, Hainan and Xizang. The northern boundary of the family lies in Himachal State in India where *Shorea robusta* reaches nearly 31 degrees north.

- 1a. Calyx in fruit with a distinct tube, calyx free; leaf venation plicate..... **1. *Dipterocarpus***
- 1b. Calyx in fruit without a tube; leaf venation not plicate.
  - 2a. Fruit sepals without basal thickening; leaf tertiary veins reticulate..... **5. *Vatica***
  - 2b. Flower sepals with basal thickening appressed to nut; leaf tertiary veins generally scalariform.
    - 3a. Ovary with distinct stylopodium; 2 calyx segments enlarged into wings or all calyx segments not enlarged into wings..... **2. *Hopea***
    - 3b. Ovary without distinct stylopodium; 3 or all calyx segments enlarged into wings.
      - 4a. Fruit sepals subequal, imbricate; bark prominently pale lenticellate..... **3. *Parashorea***
      - 4b. Fruit sepals unequal, 3 long, aliform; bark scarcely lenticellate..... **4. *Shorea***

**1 *Dipterocarpus*** C. F. Gaertner, Fruct. Sem. Pl. Suppl. Carp. 3:50. 1805.

Trees, lofty, and emergent, with grey-brown to orange flaky, prominently lenticellate bark and aromatic oily white resin, with stout buttresses. Stipules large, enclosing terminal bud, finally caducous and leaving an annular scar; leaf blades leathery, plicate in bud and  $\pm$  corrugate when opened, margin entire or sinuate-crenate; lateral veins pinnate, straight; tertiary veins subscalariform, conspicuous. Raceme 3-9-flowered, hardly branched. Flowers large, sweet-scented. Calyx with urceolate or cup-shaped free basal tube; sepals valvate, unequal. Petals white or with a reddish median

stripe , strongly contorted , pubescent or stellate pubescent especially on parts exposed in bud . Anthers equivalved , yellow , linear ; connective appendages aristate or filiform . Ovary narrowly ovoid , pubescent ; style filiform ; stigma slightly dilated . Fruit nut-like , enclosed in accrescent calyx tube ; wing-like calyx lobes 2 , erect . Seed adnate to base of pericarp ; cotyledons large , thick , unequal ; radicle inconspicuous .

About 69 species , distributed in India , Sri Lanka , Vietnam , Laos , Cambodia , Myanmar , Thailand , Malaysia , western Indonesia , and the Philippines . Two species found in China .

*Dipterocarpus gracilis* Blume , which was reported in FRPS ( Tao & Tong , 1990 ) , is certainly not found in China . It differs in the smaller size of all parts and rufous scabrous tomentum ; nearest localities are northern Thailand , the Andamans and south-east Bangladesh .

- 1a. Fruit wings conspicuously 3-or 4-veined ; fruit more than 3 cm in diam . ; leaf bud glabrous , setose or woolly , stout ,  
obtuse..... 1. *D. retusus*
- 1b. Fruit wings with only 1 much-ramified midvein ; nut less than 3 cm in diam . ; leaf buds and young twigs densely gray  
puberulent , falcate..... 2. *D. turbinatus*

1.1 *Dipterocarpus retusus* Blume , Fl. Javae 2 : 14. 1828.

*Dipterocarpus macrocarpus* Vesque ; *D. mannii* King ex U . N . & P . C . Kanjilal & Das ; *D. pubescens* Koorders & Valeton ; *D. spanoghei* Blume ; *D. tonkinensis* A. Chevalier ; *D. trinervis* Blume .

Trees , lofty , to 45 m tall . Bark grey or brown , shallowly flaky , not longitudinally fissured or only at base . Branchlets glabrous or persistently buff pubescent . Stipules green or red , lanceolate , to 15 cm , glabrous or pubescent outside ( always stellate pubescent on young trees ) ; petioles glabrous ; leaf blades broadly ovate , 16 – 28 × 10 – 15 cm , leathery , abaxially sparsely or densely golden-buff stellate pubescent , adaxially white-strigose at first , sometimes glabrescent , base rounded or somewhat cordate , margin entire or sinuate-crenate in distal half , apex acute ; lateral veins 16 – 19 pairs , conspicuously elevated abaxially . Racemes axillary , 8 – 10 cm , 2 – 5-flowered . Calyx segments : 2 rather long , linear , 3 shorter and triangular . Petals reddish , sweet-scented , narrowly elliptic , 5 – 6 cm , with dense squamate hairs , margin slightly reflexed , apex obtuse . Stamens ( 25 – ) 30 ; anther linear or lanceolate , ca. 5 mm , sagittate at base , coherent ; connective appendages aristate ; filaments filiform , dilated at base . Ovary narrowly ovoid , sericeous-tomentose , 3-celled , cells 2-ovuled ; style finely terete , with long silky hair on lower half . Nut ovoid , densely yellow-grey-tomentellate ; dilated calyx segments 2 , red , linear-lanceolate , to 19 – 23 × 3 – 4 cm , leathery , stellate-tomentellate , apex rounded , 3 – 5-veined . Fl. May-Jun , fr. Dec-Jan following yr .

Humid valley rain forests and dense forests on limestone ; to 1000 m . SE Xizang ( Siang , Subansiri ) , SE and W Yunnan ; India , Indonesia , Laos , Malaysia , Myanmar , Thailand , Vietnam .

Still locally abundant in the eastern Himalayan foothills, rare now in Yunnan, its distribution affected by habitat loss. The wood is heavy and is used for building houses. The tree is source of a balsam used for caulking boats.

This species is very variable at the extremes of its range: China, northern Vietnam and Java. *Dipterocarpus macrocarpus* and *D. tonkinensis* were recognized on account of their dense tomentum on twigs, bud and leaf undersurface; *D. mannii* by its somewhat smaller parts and ca. 25 stamens. Two varieties are recognized in China, which may co-occur in the same stand: parts glabrescent in var. *retusus*; parts persistently tomentose in var. *macrocarpus*.

**1.2 *Dipterocarpus turbinatus*** C. F. Gaertner, Fruct. Sem, Pl. Suppl. Carp. 3: 51: 1805.

*Dipterocarpus jourdainii* Pierre; *D. laevis* Behanan-Hamilton.

Trees, lofty, ca. 35 m. tall. Bark grey or dark brown, shallowly longitudinally fissured and flaky. Branchlets glabrous. Stipules 2–6 cm, densely, shortly dark grey- or dark yellow-puberulent; petioles 2–3 cm, densely grey-puberulent or glabrescent; leaf blades ovate-oblong, 20–30 × 8–13 cm, leathery, glabrous or sparsely stellate pubescent, base rounded or somewhat cordate, margin entire or sometimes sinuate, apex acuminate or acute; lateral veins 15–20 pairs, conspicuously elevated abaxially. Racemes axillary, 3–6-flowered. Calyx segments: 2 linear, 3 shorter, all glabrous, outside glaucous. Stamens ca. 30; anthers linear-lanceolate; connective appendage filiform. Ovary densely pubescent; style terete, silver grey-tomentose on lower half. Nut ovoid or narrowly ovoid, densely adpressed-tomentose; calyx tube glabrous, glaucous, wing-like calyx segments 2, linear-lanceolate, 12–15 × ca. 3 cm, glabrous, minutely papillate near much-ramified midvein. Fl. Mar-Apr, fr. Jun-Jul.

S and W Yunnan (cultivated); Cambodia, India, Myanmar, Thailand. A source of balsam.

**2 *Hopea*** Roxburgh, Pl. Coromandel 3: 7. 1811, nom. cons.

*Balanocarpus* Beddome; *Dioticarpus* Dunn; *Hancea* Pirre; *Pierrea* Heim; *Petalandra* Hance.

Trees, evergreen, of main canopy or understory, white-resinous. Stipules small, caducous; leaf blades entire, thinly leathery; lateral veins pinnate; tertiary veins scalariform or subreticulate (Chinese species). Flowers sessile or shortly pedicellate, in lax panicles of unilateral racemes; bracts early caducous, linear. Calyx segments 5, imbricate. Petals 5, their naked parts usually pubescent in bud. Stamens (10–) 15, slightly connate and adnate to petals; anthers ovate, small, subequal; connective appendage aristate or filiform. Ovary ovoid, with prominent filiform style, or hour-glass shaped, with short tapering style. Fruit ovoid or globose; pericarp usually thin, waxy; 1-seeded, closely surrounded by thickened base of calyx segments; 2 fruit sepals wing-like, linear, or all orbicular or ovate, subequal.

Source of a damar resin used in varnished. The wood is finely grained, very durable and used for making boats, bridge and furniture.

About 104 species, distributed in S India, Myanmar, Thailand, Vietnam, Laos, Cambodia, Malaysia, Indonesia, Papua New Guinea and the Philippines. Four species in China.

- 1a. Ovary globose to ovoid , style columnar ; flaky barked trees. ( Section , Subsection *Hopea* ).
  - 2a. Two fruit sepals wing-like ; leaf base obtuse , subequal , lateral veins 9 – 12 pairs. . . . . 2. *H. hainanensis*
  - 2b. Fruit sepals subequal , suborbicular ; leaf base strongly unequal , subcordate ; lateral veins 3 – 5 pairs  
..... 3. *H. reticulata*
- 1b. Ovary hour-glass shaped ; style short , tapering ; smooth-barked trees. ( Subsection *Pierrea* ).
  - 3a. Fruit sepals unequal , two wing-like ; leaf lateral veins , 8 – 12 pairs. .... 1. *H. chinensis*
  - 3b. Fruit sepals unequal , suborbiculate-ovate ; leaf lateral veins 7 – 9 pairs. .... 4. *H. shingkeng*

2.1 *Hopea chinensis* ( Merrill ) Handel-Mazzetti , Sinensia 2 : 131. 1932.

*Shorea chinensis* Merrill , Philipp. J. Sci. 21 : 503. 1922 ; *Hopea hongayanensis* Tardieu-Blot ; *H. mollissima* C. Y. Wu ; *H. jianshu* Y. K. Yang *et al.*

Trees , 15 – 20 m tall , with aromatic white resin. Bark grey-black , smooth. Branchlets red-brown , white-lenticellate , gray-stellate pubescent , grey-tomentellate , or glabrous. Petioles dark brown , ca. 1 cm , glabrous or sparsely or densely yellowish pubescent ; leaf blades 7 – 26 × 2 – 8 cm , oblong to oblong-lanceolate , leathery , abaxially sparsely pubescent or glabrous , adaxially glabrous or both densely stellate pubescent ; base rounded or cuneate , slightly asymmetrical , margin entire , apex acuminate or caudate-acuminate ; lateral veins 8 – 12 pairs , conspicuously elevated abaxially. Panicle axially , slender , few flowered , 4 – 18 cm , sparsely or densely pubescent , with ciliate margin. Sepals 5 , imbricate , ovate , glabrous or pubescent. Petals 5 , reddish , contorted , elliptic , ca. 3 – 4 mm , yellow-tomentose on parts exposed in bud. Stamens ( 10 – ) 15 ; anthers ovoid , subequal ; connective appendages aristate , ca. 3 × as long as ovary ; style short , tapering. Fruit dark brown , ovoid , apiculate ; calyx segments : 2 wing-like , oblong-lanceolate or oblong , 8 – 12 × ca. 2.5 cm , glabrous , apex rounded , longitudinally 12-veined. Fl. Jun-Jul , fr. Oct-Dec.

Valley forest , forests on mountain slopes , hills ; 300 – 600 m. Guangdong , S and SW Guangxi , SE Yunnan ( Jiangcheng , Luchun , Pingbian ) ; Vietnam ( Tonkin ). An endangered species is being threatened by timber exploitation. The wood is durable and is used for making boats , bridges and furniture.

2.2 *Hopea hainanensis* Merrill & Chun , Sunyatsenia 5 : 134. 1940.

Trees , ca. 20 m tall , with aromatic white resin. Bark gray or brown , flaky , white-lenticellate. Petioles robust , ca. 2 cm , glabrous or farinose-scurfy ; leaf blades oblong to oblong-ovate , 8 – 14 × 5 – 8 cm , thinly leathery , both surfaces glabrous or farinose-scurfy , base rounded , margin entire , apex slightly obtuse or acuminate ; lateral veins 9 – 12 pairs , conspicuously elevated abaxially. Flowers arranged in lax panicle of unilateral racemes. Sepals ovate , ca. 2.5 mm , apex rounded , outer 2-pubescent on whole surface. Petals oblong or oblong-elliptic , ca. 6 mm. Stamens 15 , anthers ovoid ; connective appendages filiform , ca. 1 mm. Ovary and stylopodium ovoid , pubescent ; style short , glabrous ; stigma conspicuous. Fruit ovoid , waxy , apiculate ; calyx segments : 2 wing-like oblong or oblanceolate , 5 – 7 × ca. 2.5 cm , longitudinally 9 – 11-veined , sparsely stellate pubescent. Fl. Jun-Jul , fr. Nov-Dec.

Dense forests ; ca. 700 m. Hainan ; N Vietnam. An endangered species of scattered occurrence. The wood is durable and is used for making boats , and building bridges and houses.

**2.3 *Hopea reticulata*** Tardieu Blot , Notul. Syst. , Paris , 10 : 123. 1942.

*Hopea exalata* W. T. Lin , Y. Y. Yang & Q. S. Hsue.

Trees , ca. 15 m tall , with dark brown smooth bark , later becoming flaky , and aromatic white resin. Branchlets densely grey-yellow-tomentose at first , soon sparsely so. Petioles 6 – 8 mm , grey-tomentose ; leaf blades ovate to ovate-lanceolate , 5 – 12 × 3 – 6 cm , leathery , base oblique or cordate , sometimes rounded , margin entire , apex acuminate ; basal veins 5 or 6 , lateral veins 3 – 5 pairs , slightly elevated abaxially. Panicles axillary or terminal , 6 – 11 cm , slender , few-flowered , sparsely pubescent or subglabrous. Calyx segments 5 , imbricate , suborbicular , glabrous. Petals 5 , reddish , obovate-elliptic , ca. 5 mm , outside tomentose , ciliate on margin. Stamens ( 10 – ) 15 ; anthers ellipsoid ; connective appendages filiform. Ovary and stylopodium pyriform , with median constriction , glabrous ; style short. Fruit ovoid ; pericarp thin , glabrous ; calyx lobes subequal , short , to 8 × 7 mm. Fl. Mar-Apr , fr. May-Jun.

Forests on mountains slopes , hills ; ca. 400 m. Hainan ( mt. range between Yaxian and Baoting ) ; Vietnam. A rare species vulnerable to extirpation. The wood is durable , and is used for building houses and bridges , and making furniture.

This species was earlier separated from *Hopea exalata* by having 15 as opposed to 10 stamens , but we find that both numbers are found in each case.

**2.4 *Hopea shingkeng*** ( Dunn ) Bor , Indian Forest Rec. , Bot. , 2 : 227. 1941.

*Vatica shingkeng* Dunn , Bull. Misc Inform. Kew 1920 : 108. 1920.

Trees , evergreen , to 18 m tall ; bark smooth , brown mottled. Parts glabrous. Twigs slender. Stipules fugacious ; petiole ca. 1 cm. Leaf blades 9 – 15 × 2.5 – 5 cm , elliptic-oblong to lanceolate , herbaceous , base broadly cuneate , apex caudate ; lateral veins 7 – 8 pairs , depressed above , slender but prominent beneath , tertiary veins laxly scalariform. Panicles to 15 cm , lax , slender ; flower buds ca. 8 mm , narrowly ovoid , secund. Sepals broadly ovate , subequal. Petals ca. 8 × 4 mm , lanceolate , pubescent on parts exposed in bud. Stamens 15 ; anthers oblong ; connective appendages c. 3 × length of anthers , slender. Ovary and stylopodium hour-glass shaped , with short tapering style. Fruit sepals unequal , 2 outer lobes to 3 × 2 cm , ovate , obtuse ; 3 inner lobes to 1.5 cm , narrowly ovate ; nut to 15 mm , ovoid-globose , apex apiculate.

In moist evergreen forest , locally abundant at 300 – 600 m ; SE Xizang ( Siang , Arbor Hills ).

**3 *Parashorea*** Kurz , J. Asiat. Soc. Bengal , Pt. 2 , Nat. Hist. Sc. 39 ( 2 ) : 65. 1870.

Trees , large , evergreen , with stout buttresses. Bark fissured , shallowly flaky , greyish mauve-brown , with small but prominent white lenticels at base of fissures and on buttress crown. Stipules lanceolate , persisting in juveniles. Leaves oblong to lanceolate. Inflorescence racemose. Flowers and fruit as in *Shorea* , but flower sepals narrowly lanceolate , imbricate at base only ; petals falling separately. Stamens 15 ; filaments short , dilated ; pollen sacs narrowly oblong , glabrous ; connective appendages

relatively stout, short or columnar. Ovary ovoid, small, pubescent, style long, filiform. Fruit sepals subequal, with narrow thickened base often becoming valvate in fully ripe fruit, narrowly wing-like, long; nut globose or ellipsoid.

14 species, in southern Burma, Thailand, Laos, Vietnam, Cambodia, Malaysia, western Indonesia and Philippines. One species in China.

This species in China differs from other species in the seedling without silvery abaxial leaf surface, and the pubescence on the nut, which obscures the normally distinct pale lenticels; but this species is otherwise typical. *Parashorea* has wood anatomical similarities to the red meranti group of *Shorea*; molecular phylogenetic evidence (Kajita *et al*, 1998) suggests that it is basal to them. Formal review of the status of genera in tribe Shoreae must await further molecular evidence.

### 3.1 *Parashorea chinensis* H. Wang, Acta Phytotax. Sin. 15 (2): 11. 1977.

*Shorea chinensis* (Wang Hsie) H. Zhu 1992, non Merrill 1922; *Parashorea chinensis* var. *kwangsiensis* Lin Chi; *S. wangtianshuae* Y. K. Yang & J. K. Wu.

Trees, lofty evergreen emergent, 40 (– 60) m tall, 0.6 – 1.5 m in diam., with large stout straight buttresses. Bark gray or brown, shallowly longitudinal-fissured on upper part, but exfoliating in masses on lower part, with prominent lines of lenticels on buttress ridges and in fresh fissures. Branchlets grey- to yellow-brown scurfy pubescent or tomentose, orbicular-lenticellate. Stipules caducous, ovate, to 15 × 5 mm in juveniles, papery, scurfy pubescent or tomentose, longitudinally 5-veined, leaving short scars; petioles 1 – 3 cm, densely pubescent; leaf blades elliptic-lanceolate, 6 – 20 × 3 – 8 cm, leathery, both surfaces scurfy pubescent or tomentose, base rounded, margin entire, apex acuminate; lateral veins pinnate, 14 – 19 pairs, conspicuously elevated abaxially; tertiary veins subreticulate, conspicuous. Flowers in 5 – 12 cm, densely gray-yellow-scurfy pubescent or tomentose axillary or terminal cymose panicles, sweet-scented; cymes 2-bracteate at base, 3 – 8 flowered. Pedicel 2-bracteolate; bracts and bracteoles ovate or ovate-elliptic, 6 – 13 × 4 – 7 mm, longitudinally 6 – 9 veined. Sepals narrowly lanceolate, outside pubescent. Petals yellow-white, 6 – 11 × 3 – 7 mm, 10 – 14 veined. Stamens 15; anthers linear-lanceolate, outer locules apiculate, inner cells much smaller than outer; connective appendages acicular, almost as long as outer locules. Ovary narrowly ovoid, densely white-silky pubescent; style columnar, ca. 2 × as long as ovary, glabrous; stigma small, slightly 3-lobed. Fruit ripening ellipsoid, densely silver-silky pubescent; calyx segments subequal, wing-like, 6 – 8 × 0.6-cm, longitudinally 5 – 7 veined, bases narrow, not completely enveloping fruit, often becoming valvate. Fl. May-June, fr. Aug-Sep.

Valleys, mountain slopes, hills, dense forests on limestone and other rocks; 300 – 1100 m. Guangxi (Bama, Longchou, Napo), S and SE Yunnan (Hekou, Mengla); N. Vietnam. The wood is brown-yellow, fine grained, hard and durable, and is used for various purposes.

The homogeneity of genetic structure of *P. chinensis* in different populations supported *P. chinensis* var. *guangsiensis* should be reduced into *P. chinensis* (Li & Xu, 2001b).



*Pentacme* A. de Candolle.

Trees, usually large, prominently buttressed. Bark usually fissured, flaky. Stipules large or small, caducous; leaf blades  $\pm$  leathery, margin entire; tertiary veins parallel (in China). Flowers in axillary or terminal lax cymose panicles; bracts persistent, caducous, or absent. Sepals with 3 outer larger than 2 inner. Petals white, yellow or pink, usually, usually pubescent. Stamens (12 – ) 15 or 20 – 100; anthers ovate, oblong, or panduriform (in China); connective subulate-cuspidate or stout, club-sharped; valves equal or outer one slightly larger. Ovary ovoid, pubescent; style subulate; stigma entire or 3-toothed. Fruit usually 1-seeded, closely surrounded by thickened bases of accrescent calyx segments; sepals developed into lorate wings, outer 3 much larger than 2 inner.

About 200 species, distributed in NE India, Myanmar, Thailand, Laos, Cambodia, Malaysia, Indonesia, Philippines and Indochina. Two species in China.

- 1a. Evergreen tree with laminated inner bark; anthers ellipsoid, glabrous; connective appendage long, acicular, glabrous; stamens 15. .... **1. *S. assamica*** (Section *Anthoshorea*)
- 1b. Deciduous tree without laminated inner bark; anthers panduriform, setose towards apex; appendages short, stout, sparsely setose; stamens > 25. .... **2. *S. robusta*** (Section *Shorea*)

#### **4.1 *Shorea assamica*** Dyer in J. D. Hooker, Fl. Brit. India 1:307. 1874, ssp. *assamica*

Trees, evergreen, emergent, to 50 m tall, with aromatic white resin smears. Bark dark brown or grey-brown, irregularly exfoliating in scales; inner bark laminated. Branchlets densely grey-yellow-tomentose, orbicular-lenticellate. Stipules oblong or falcate-ovate, ca. 2 cm, longitudinally 10- or 11-veined, densely gray-yellow-tomentose, persistent on juveniles; petioles ca 1 cm, densely yellow-tomentose; leaf blades ovate-elliptic, 6 – 12  $\times$  3 – 6 cm, thinly leathery, abaxially stellate pubescent, adaxially tomentose on midvein, base rounded or slightly cordate, margin entire, apex acuminate; midvein elevated abaxially, conspicuously impressed adaxially; lateral veins 12 – 19 pairs, pinnate; tertiary veins loosely scalariform, conspicuous. Flowers in axillary or terminal cymose panicles; bracts caducous. Sepals: outer 3 elliptic, ca. 8 mm, inner 2 lanceolate, ca. 6 mm, all grey-yellow-tomentose. Petals yellow-white, contorted, narrowly oblong, longitudinally 11-veined, adpressed-tomentose outside. Stamens 15; anthers ovoid; connective appendages filiform, ca. 3 mm. Ovary ovoid, sparsely pubescent; nut to 15  $\times$  15 mm, ovoid; style narrowly cylindric; stigma 3-lobed. Sepals lobes wing-like; long wings linear-oblong, 8 – 10  $\times$  ca. 1.5 cm, longitudinally 10 – 14-veined, short wings linear-lanceolate, 3 – 5 cm; all tomentellate, base broad, dilated, thickened, completely enveloping fruit. Fl. Jun-Jul, fr. Dec-Jan following yr.

Tropical low valley forests; to 1000 m. SE Xizang, W Yunnan; India, Indonesia, Malaysia, Myanmar, Philippines, Thailand. A rare species in China, threatened by habitat loss.

#### **4.2 *Shorea robusta*** C. F. Gaertner, Fruct. Sem. Pl. 3:48, t. 186. 1805.

Trees to 40 m tall,  $\pm$  tardily deciduous; trunk to 2 m diam.; crown spreading; bark grey to dark red-brown, becoming fissured and flaky; inner bark not laminated; wood hard. Heartwood dark

brown. Branchlets densely buff scabrous, pubescent. Stipules lanceolate, lepidote, fugacious; petioles 2 – 2.5 cm, buff, scabrous, pubescent; leaf blade 10 – 40 × 5 – 24 cm, ovate to oblong, thinly leathery, glabrous, base obtuse to cordate, apex acuminate; midvein evident above, prominent beneath; lateral veins ca. 12 pairs, prominent abaxially. Flowers subsessile, on to 25 cm long panicles; branches racemose, secund; bracts minute, caducous; buds lanceolate. Sepals to 2 mm in bud, ovate, densely buff pubescent. Petals creamy-yellow or sometimes with a medium pink stripe, 10 – 15 × ca. 5 mm, linear, strongly contorted; stamens many; anthers panduriform; connective appendages short, exceeding anther apex, sparsely setose. Ovary ovoid, densely buff pubescent. Fruit sepals unequal, spatulate, sparsely pubescent, 3 longer to 8 × 1.5 cm, 2 smaller to 3.5 × 0.5 cm; nut ca. 5 × 12 mm, ovoid. Fl. Feb-May, fr. May-July.

Gregarious in savanna woodland; to 800 m. Rare in China at Kameng and possibly Mo-Fuo, SE Xiang; NE and Central India (from Arunachal W to himachal including Nepal terai, and SE to Tripura and Andhra).

## 5 *Vatica* Linnaeus, Mant. Pl. 2:152. 1771.

*Pachynocarpus* J. D. Hooker; *Retinodendron* Korthals.; *Sunaptea* J. W. Griffith.

Trees of the main canopy and understory, unbuttressed; white-resinous, bark smooth, grey, often with annular striations. Stipules small, caducous; leaf blades ± leathery, margin entire, pinnate-veined; tertiary veins conspicuous, reticulate. Flowers in axillary or terminal cymose panicles, usually stellate pubescent. Calyx tube short (in China), sepals narrowly imbricate, equal or subequal. Petals white, often with a mauve suffusion, large, lorate, falling separately. Stamens 15; filaments unequal, stout; anthers ellipsoid; connective appendages short, obtuse. Ovary ovoid, pubescent; style short, cylindric; stigma capitate or conical, prominent, entire or dentate. Nut globose or ellipsoid, 1-or 2-seeded; calyx segments equal or unequal, with 2 developed into long wings.

About 65 species, distributed in E and S India, Myanmar, Sri Lanka, Thailand, Cambodia, Laos, Vietnam, Malaysia, Indonesia and Philippines. Three species in China.

- 1a. Fruit sepals short, subequal, reflexed; leaf glaucous abaxially..... 2. *V. lanceifolia*
- 1b. Fruit sepals unequal, 2 wing-like; leaf not glaucous abaxially.
  - 2a. Leaf lateral veins 12- or more pairs..... 1. *V. guangxiensis*
  - 2b. Leaf lateral veins 7 – 10 pairs..... 3. *V. mangachapoi*

### 5.1 *Vatica guangxiensis* S. L. Mo, Acta Phytotax. Sin. 18:232. 1980.

*Vatica xishuangbannaensis* G. T. Tao & J. H. Zhang.

Trees, to 40 m tall, ca. 90 cm diam. Branchlets of current year densely yellow-brown to dark-brown stellate tomentose, old branchlets glabrous. Petioles 1.5 – 2 cm, dense yellow-brown pubescent; leaf blades narrowly elliptic to elliptic-lanceolate, 6 – 19 × 1.5 – 4 cm, thinly leathery, both surfaces with grey-yellow stellate hairs, glabrescent or abaxially sparsely stellate pubescent and adaxial-

ly glabrous, base cuneate, margin entire, apex acuminate or short acuminate; lateral veins 12 – 18 ( – 20 ) pairs, elevated on both surfaces. Panicles terminal or axillary, robust, to 12 cm, densely yellow-brown pubescent. Sepals: both surfaces densely pubescent. Petals white or reddish, ca. 15 × 5 mm, pubescent on parts exposed in bud. Stamens 15; filaments short, triangular; anthers oblong; connective appendages short, obtuse. Ovary subglobose, densely gray-yellow pubescent; style glabrous; stigma capitate, 3-lobed. Nut subglobose, pubescent; calyx without basal cup adnate to ovary; fruit sepals: 2 longer oblong-elliptic, to 8 × 2 cm, obtuse, longitudinally 5-veined; 3 shorter linear-lanceolate, to 2 × 0.5 cm, all sparsely stellate pubescent. Fl. Apr. – May, fr. Jul–Aug.

Mountain slopes, hills; 800 – 1000 m. SW Guangxi ( Napo ), S Yunnan ( Mengla ). An endangered species, threatened by habitat loss. The wood is durable, and is used for making boats, furniture, and building houses.

Zhu & Wang ( 1992 ) stated that it was unreliable to separate *Vatica xishuangbannaensis* from *V. guangxiensis* just based on the different number of leaf lateral veins, and later Li & Xu ( 2001a ) support such a combination on the basis of the population genetic data. *Vatica fleuryana* Tardieu, based on a type in flower from Vietnam but unknown in fruit, is associated by Smitinand, Vidal & Ho ( Fl. Cambodge, Laos & Vietnam 25 : 57. 1990 ) with *V. diospyroides* Sym., but may be the correct name for this species. *V. diospyroides* is a swamp species. Fruit will resolve the issue.

## 5.2 *Vatica lanceifolia* Blume, Mus. Bot. 2 : 31. 1857.

*Vateria lanceifolia* Roxburg, Fl. Ind. 2 : 601. 1824.

Trees, evergreen, to 12 m tall. Bark pale gray-green, mottled smooth, Twigs slender, gray-brown puberulent. Petiole ca. 2 cm, caducous, puberulent; stipules fugacious; leaf blade 10 – 23 × 3 – 8 cm, elliptic to lanceolate, usually narrow, thinly leathery, abaxially glaucous, with base cuneate, acumen slender; midvein raised abaxially; lateral veins 10 – 15 pairs, slender, raised abaxially, evident adaxially. Inflorescence irregularly racemose, to 12 cm, lax, or fascicled flowers, scented; sepals ca. 3 mm, deltoid, outside densely puberulent. Petals to 2 mm, lorate, pubescent on parts exposed in bud. Stamens 15; anthers ovate-oblong; connective appendage exceeding anther apices, stout. Ovary ovoid, puberulent; style stout, ca. as long as ovary; stigma prominent. Nut to 3 × 2.5 cm, globose, with 3 loculicidal sutures, becoming rugulose, pink-brown; fruit sepals subequal, to 10 × 8 mm, lanceolate, cordate, papery, ascending.

Relict in evergreen valley forests; to 900 m. SE Xizang ( Kameng, Siang ); NE India, NW Myanmar.

## 5.3 *Vatica mangachapoi* Blanco, Fl. Filip. 1 : 401. 1837.

*Anisoptera mangachapoi* ( Blanco ) de Candolle; *Dipterocarpus mangachapoi* Blanco; *Mocanera mangachapoi* Blanco; *Pteranthera sinensis* Blume; *Shorea mangachapoi* ( Blanco ) Blume; *Vatica apteranthera* Blanco; *V. hainanensis* H. T. Chang & L. C. Wang.

Trees, white-resinous, to 20 m tall. Branchlets stellate-puberulent. Petioles 1.5 – 2.0 cm, densely gray-yellow puberulent; leaf blades oblong to lanceolate, 5 – 13 × 2 – 5 cm, leathery, both surfaces glabrous or sparsely pubescent, base rounded or truncate, margin entire, apex acuminate or

acute ; lateral veins 7 – 10 pairs , elevated on both surfaces , tertiary veins conspicuous . Panicle terminal or axillary , 4 – 8 cm , slender , silver-gray stellaate pubescent . Calyx grey-yellow pubescent ; sepals ovate-lanceolate or oblong , unequal , ca. 3.2 cm . Petals white , sometimes yellowish or reddish , oblong or linear-spatulate , ca. 10 × 4 mm , outside pubescent , inside glabrous . Stamens 15 ; filaments short , unequal ; anthers oblong ; connective appendages short , obtuse . Ovary globose , densely puberulent ; style short ; stigma capitate . Fruit globose ; 2 calyx segments longer , 3 – 4 × 1 – 1.5 cm , lorate , apex rounded , longitudinally 5-veined ; 3 shorter segments to 10 × 4 mm , lanceolate , apex acute . Fl. May-Jun , fr. Aug-Sep .

Forests on hills , mountain slopes ; to 700 mm . Hainan ; Indonesia , Philippines , Malaysia , Thailand , Vietnam . Vulnerable to extirpation in China due to habitat loss . The wood is durable , and is used for making boats , and building bridges and houses .

## References :

- Ashton PS , 1982 . “ Flora Malesiana . Series I—Spermatophyta . Flowering Plants ” Vol. 9 , Part 2 , “ Dipterocarpaceae ” [ M ] . Martin Nijhoff Pub , The Netherlands .
- Ashton PS , 1988 . Dipterocarp biology as a window to the understanding of tropical forest structure [ J ] . *Ann Rev Ecol Syst* , **19** : 347—370
- Dayanandan S , Ashton PS , Williams SM , *et al* , 1999 . Phylogeny of the tropical tree family Dipterocarpaceae based on nucleotide sequences of the chloroplast *rbcl* gene [ J ] . *American Journal of Botany* , **86** : 1182—1190
- Kajita T , Kamiya K , Nakamura K , *et al* , 1998 . Molecular phylogenetic of Dipterocarpaceae in Southeast Asia based on Nucleotide sequences of *matK* , *trnL* intron , and *trnL-trnF* intergenic spacer region in chloroplast DNA [ J ] . *Molecular Phylogenetics and Evolution* , Vol. **10** ( 2 ) ; 202—209
- Li QM ( 李巧明 ) , Xu ZF ( 许再富 ) , 2001a . Genetic diversity and population differentiation of *Vatica guangxiensis* [ J ] . *Acta Botanica Yunnanica* ( 云南植物研究 ) , **23** ( 2 ) : 201—208
- Li QM ( 李巧明 ) , Xu ZF ( 许再富 ) , 2001b . Population genetic structure and differentiation of *Parashorea chinensis* ( Dipterocarpaceae ) [ J ] . *Acta Botanica Yunnanica* ( 云南植物研究 ) , **23** ( 3 ) : 313—320
- Lin Q , 2000 . Dipterocarpaceae . In Fu LK , *et al* . , ( eds. ) , Higher Plants of China [ M ] , Vol 4 : Qindao : Qingdao Publishing House , China , 565—572
- Londonn AC , Alvarez E , Forero E , *et al* , 1995 . A new genus and species of Dipterocarpaceae from the Neotropics . I. Introduction , Taxonomy , Ecology and Distribution [ J ] . *Brittonia* , **47** : 225—236
- Takhtajan A , 1997 . Diversity and classification of plants [ M ] . New York : Columbia University Press , USA
- Tao GD , Tong SQ , 1990 . Dipterocarpaceae . In Li H W , ( ed. ) Flora Reipublicae Popularis Sinicae [ M ] . Beijing : Science Press , China , Vol. **50** ( 2 ) : 113—131
- Tsumura Y , Kawahara T , Wickneswari R , *et al* , 1996 . Molecular phylogeny of Dipterocarpaceae in Southeast Asia using RFLP of PCR-amplified chloroplast genes [ J ] . *Theor Appl Genet* , **93** : 22—29
- Yang YK , Wu JK , 1994 . Discussion about name of *Shorea chinensis* ( Wang Hsie ) H. Zhu [ J ] . *Journal of Wuhan Botanical Research* , **12** ( 2 ) : 189—192
- Zhu H ( 朱华 ) , Wang H ( 王洪 ) , 1992 . Notes on the two species of family Dipterocarpaceae found in Xishuangbanna [ J ] . *Acta Botanica Yunnanica* ( 云南植物研究 ) , **14** ( 1 ) : 21—24